491.1 DESCRIPTION

This work consists of preparation of the existing bridge deck and furnishing and placing the Polysulfide Epoxy with quartzite sand broadcast as the cover aggregate.

491.2 MATERIALS

Materials shall conform to the following Sections:

A. Cement: Type III Cement, Section 750.

B. Fine Aggregate: Section 800

C. Coarse Aggregate: Shall conform to Section 820 for Coarse Aggregate for Bridge Deck Resurfacing (Size No. 3) of the Standard Specifications. Coarse Aggregate to be used shall consist of either crushed quartzite or other crushed ledge rock. If crushed ledge rock other than quartzite is to be used, it shall be from a source approved by the Engineer.

D. Water: Section 790

E. Admixtures: Sections 751 and 752

F. Grout: Grout for bonding new concrete to old concrete shall consist of equal parts by weight of Portland Cement and sand, mixed with sufficient water to form a thick slurry. A grout admixture shall be added to the grout mixture in accordance with the manufacturer's recommendations.

G. Grout Admixtures: Shall be a one component acrylic bonding additive. The additive shall be one of the grout admixtures from the Approved Products List, or an approved equal as determined by the Office of Bridge Design.

H. Cover Aggregate: Section 805

I. Curing: Curing materials shall conform to Section 821.1A & C. No curing compounds will be allowed.

J. Polysulfide Epoxy: Shall be a two component epoxy consisting of a base component and hardener. Both shall be supplied in containers lined with a chemically resistant liner to prevent exposure of the components to metal. The components shall be stored at temperatures greater than 60^{o} F (16^{o} C). The Polysulfide epoxy shall be one of the epoxies from the Approved Products List or an approved equal as determined by the Office of Bridge Design.

491.3 CONSTRUCTION REQUIREMENTS

A. Surface Preparation

1. Removal of Rubberized Asphalt Chip Seal (RACS): When removal of RACS is specified on the plans, the removal shall be in accordance with these provisions. Alternate removal

techniques may be submitted to the Bridge Construction Engineer, through the proper channels, for approval. Removal of existing RACS shall consist of heating the existing RACS on a bridge deck to a specified temperature and removing the heated RACS from the bridge deck surface by scraping with a front end loader and hand tools.

a. Heating Requirements: The existing RACS on the deck surface shall be heated to a temperature range of 125° F to 140° F (52° C to 60° C) as measured using an infrared pyrometer. The infrared pyrometer shall be furnished by the Department. Removal of the RACS shall not proceed until the RACS is between the specified temperatures.

Heating the existing RACS on the deck surface shall be accomplished with mobile heaters capable of heating the RACS to the specified temperature range. The heating equipment shall be placed directly in front of the RACS removal equipment for the full width of the RACS removal equipment. Portable propane heaters are acceptable.

A visual indication that the existing RACS on the deck surface is nearing the desired temperature will be the appearance of small glossy black spots on the RACS surface.

b. Mechanical Removal Requirements: The removal of the heated RACS on the deck surface shall be accomplished with the blade of a front end loader bucket and hand tools.

For maximum removal efficiency with the front end loader blade, the following shall be adhered to:

1. Maintain a sharp lubricated bucket blade. The blade and hand tools used to remove the RACS shall be lubricated to prevent the heated RACS from sticking to the blade or hand tools. This lubricant shall be a non-flammable commercially available product. Apply the lubricant as necessary, as approved by the Engineer, to prevent the heated RACS from sticking to the blade.

2. Maintain a 60 to 70 degree angle between the bucket blade and the deck surface.

3. Maintain as much downward force on the bucket as possible without damaging the underlying bridge deck as approved by the Engineer.

4. Maintain complete contact with the bridge deck and the blade during removal operations. Rate of removal will be maintained below the speed at which the bucket blade begins to “chatter” on the deck.

The Contractor shall use hand tools to remove the RACS in areas where the front end loader could not be used for removal such as low spots on the deck surface, adjacent to curb lines or adjacent to bridge joints.

All removed RACS shall become the property of the Contractor for his disposal in accordance with the Standard Specifications.

c. Acceptance Criteria: The intent of this procedure is to remove all of the aggregate and as much of the asphalt material as possible from the deck surface. Adherence to the construction procedures outlined in this document as approved by the Engineer shall constitute acceptance.

2. Removal and Replacement of Loose and Delaminated Concrete: Removal of delaminated and loose concrete and bituminous patches (when present) shall be accomplished prior to grinding of the bridge deck (when bridge deck grinding is specified in the plans). Removal shall be by jackhammers or chipping hammers as approved by the Engineer. Jack hammers and mechanical chipping tools shall not be operated at an angle in excess of 45 degrees measured from the surface of the concrete. The edges of the resulting hole in the deck shall be nearly vertical or tapered inward from the top down to a minimum depth of one inch. A reversed taper will not be permitted. Saw cutting the edges of the removal area may be required if satisfactory results can not be obtained by other means. Any reinforcing steel that is exposed by the concrete removal operations shall be thoroughly cleaned by abrasive blasting. Care shall be taken during the removal operations not to nick, gouge, or in any other way damage the in-place reinforcing steel. Any damage to the in-place reinforcing steel caused by the removal operations shall be repaired ad directed by the Engineer at no cost to the Department.

Prior to placing concrete within the concrete removal areas, the removal areas shall be thoroughly cleaned of loose or foreign material by abrasive blasting. The abrasive blasting shall be to the extent that all surface laitance is removed. Abrasive blasting shall expose the coarse aggregate and remove rust from any exposed reinforcing steel. After abrasive blasting, the surface shall be cleaned by air blast using a compressor equipped with a satisfactory operating filter.

Grout shall be applied on all of the existing concrete surfaces that will be in contact with the new concrete immediately before concrete placement. The grout shall be scrubbed into the surface in a thin and uniform coat. Care shall be taken to ensure that excess grout does not collect in pockets, that grout is confined only to the immediate area in which new concrete is to be placed, and that the rate of application is limited to an amount that will be covered with concrete before it dries.

The existing surface at the time of concrete placement shall be at least 40º F (4° C), measured by a thermometer placed against the surface and covered with an insulating blanket. The concrete shall be between 45° F (7° C) and 80° F (27° C) at the time of placement and shall be maintained at or above 45° F (7° C) for at least 72 hours.

The concrete slump at the time of placement shall be maintained between 1 and 4 inches (25 and 100 mm), and the concrete shall contain 6.5% $\pm$ 1% entrained air.

The following Portland cement concrete mix design shall be used for concrete replacement:

Mix Design Proportions

	Mix/Bag lbs. (kg)	Mix/Cu. Yd. lbs. (kg)	Absolute Volume (per unit volume)
❶ Water	42.3 (19.19)	360 (213.58)	0.213675
❷ Sand	140.6 (63.42)	1190 (706.00)	0.268621
Cement	94.0 (42.64)	800 (474.62)	0.149790
❷ Rock	158.5 (71.53)	1342 (796.19)	0.302914
❸ Air	---	---	0.065000
TOTAL	---	3692 (2190.39)	1.000000

❶ The amount of water in this mix design is the maximum amount of water, including that due to moisture in the aggregate, that is allowed. The water actually used should initially be reduced, and then water added gradually, to achieve concrete that is within slump specifications. It will be the responsibility of the Contractor to produce concrete that is in accordance with the specifications and notes.

❷ Saturated Surface Dry (Adjustments for moisture in aggregate are required)

❸ An air content of 6.5% was used for calculation.

As soon as finishing has been completed, the new concrete exposed to the deck surface shall be given a broomed finish only.

After applying the broomed finish to the new concrete, the new concrete shall be covered with a double layer of clean wet burlap. Within one hour of covering with wet burlap, polyethylene sheeting shall be placed on the wet burlap and the surface cured for 48 hours. The wet burlap and polyethylene sheeting shall be secured to the deck surface for the specified cure time by a method to be approved by the Engineer. The curing material shall then be removed for an additional 48 hours of air cure.

All new concrete placed in the existing deck shall be allowed to cure a minimum of 10 days prior to shot blasting, abrasive blasting, vacuum cleaning, and placement of the epoxy chip seal. The bridge deck may be opened to traffic after placing the concrete but prior to shot blasting when the newly placed concrete has attained a compressive strength of 4000 psi (28 MPa).

3. **Grinding:** When grinding is specified in the plans, the entire bridge deck surface shall be ground to total coverage. When removal and replacement of loose and delaminated concrete is specified, the grinding shall not be done until the newly placed concrete has attained a strength of 4000 psi (28 MPa). Grinding shall be done no more than 7 days prior to placement of the Epoxy Chip Seal.

   When grinding is specified on a bridge deck that has had a Rubberized Asphalt Chip Seal (RACS) removed as part of the plans, the grinding shall be used to remove all of the surface residue (excluding the curb surfaces) that remains from the RACS as approved by the

Engineer. The Contractor shall have the option to use abrasive blasting to remove any minimal amount of surface residue not removed by the grinding process.

The grinding shall be performed in a longitudinal direction. The grinding shall result in a parallel corduroy texture consisting of grooves between 0.090 and 0.130 inches (2 and 3 mm) wide. The distance between the grooves shall be between 0.060 and 0.125 inches (1.5 and 3 mm). The peaks of the ridges shall not be greater than 1/16 inch (1.5 mm) higher than the bottom of the grooves. The grinding shall be uniform and shall follow the existing profile of the bridge deck. The grinding process shall not introduce dips and bumps that did not previously exist on the deck surface or in any way decrease the existing riding quality of the deck.

4. **Shot Blasting, Abrasive Blasting and Vacuum Cleaning:** After any specified (RACS) removal, removal and replacement of loose and delaminated concrete, and any specified grinding, the entire bridge deck surface will be cleaned by shot blasting to remove all foreign materials which may interfere with the bonding or curing of the Epoxy Chip Seal. The shot blasting shall remove all surface laitance and shall expose the coarse aggregate. Small areas in which shot blasting is unable to be performed (curb lines, etc.) shall be cleaned by abrasive blast cleaning.

   Upon completion of the shot blasting and abrasive blasting, the entire bridge deck shall be vacuum cleaned to remove all dust and loose materials.

   If the bridge is under traffic and the Epoxy Chip Seal is to be placed in phases, the shot blasting, abrasive blasting, and vacuum cleaning will also be accomplished in phases. At no time will vehicular traffic be allowed on any portions of the cleaned surfaces of the bridge deck.

   Cleaning by shot blasting, abrasive blasting and vacuum cleaning shall be done within 24 hours of placement of the Epoxy Chip Seal. In the event that the Epoxy Chip Seal is not placed within 24 hours or in the event that inclement weather has contaminated the surface, the surface shall be re-cleaned by abrasive blasting and vacuum cleaning.

   There shall be no visible moisture present on the surface of the concrete at the time of application of the Epoxy Chip Seal. Compressed air may be used to dry the deck surface.

   No traffic shall be allowed on any portion of the deck which has been cleaned and prepared for application of the Epoxy Chip Seal. Overlay application equipment will be allowed on the prepared deck surface, as approved by the Engineer, provided precautions have been taken to insure that the deck surface will not become contaminated by the placement equipment.

B. Equipment Grinding of the Bridge Deck shall be accomplished utilizing diamond blades mounted on a self-propelled machine designed for grinding and texturing pavement. The equipment shall be operated in such a manner that it will not strain or damage the underlying deck surface. Grinding equipment that causes ravels, aggregate fractures, or spalls shall not be permitted. Residue or excess water generated by the grinding procedure shall be removed with

vacuum equipment from the deck surface before the residue has time to set up. Vacuuming residue or excess water shall not be expelled on the approach roadway or shoulder surfaces.

Removal of delaminated concrete, loose concrete, bituminous patches and final surface preparation shall require the following equipment:

1. Concrete sawing equipment capable of sawing concrete to the specified depth.

2. Jack hammers that are 30 pounds (13.6 kg) or lighter.

3. Chipping hammers that are 15 pounds (6.8 kg) or lighter.

4. Hand tools for mixing and placing freshly mixed concrete.

5. A portable concrete mixer as approved by the Engineer.

6. Abrasive blasting equipment capable of removing rust and old concrete from exposed reinforcement and removing surface laitance from new substrate concrete.

7. Shot blasting equipment capable of removing substrate concrete to a depth of ¼" (6 mm).

8. Vacuuming equipment capable of removing excess water, coarse and fine residues.

C. Epoxy Chip Seal

1. Epoxy Application Requirements: The Contractor shall place the Epoxy in accordance with the manufacturer's recommendations, as approved by the Engineer, and with the following requirements:

Epoxy application to the deck surface shall be when an air temperature, bridge deck temperature and an epoxy temperature of 65° F (18° C) or greater can be anticipated for at least a 4 hour period. The air temperature shall be at least 5° F (2.8° C) above the dew point temperature.

The application of the Epoxy Chip Seal System shall not be made on a wet or damp surface. In the event of rain, the surface shall be dried for 24 hours prior to application. Application of the Epoxy Chip Seal System shall not be made when rain is forecast. Deck drain openings shall be temporarily sealed during epoxy placement as approved by the Engineer.

Epoxy shall be broadcast over the deck surface using Gauge Rakes or stiff bristled brooms (approved by the Engineer) to yield a wet film thickness of epoxy of 40 mils (0.040") (1 mm) with a tolerance of $\pm$ 3 mils (0.1 mm)

A gallon of the two component epoxy mixed at a 2:1 (component to hardener) ratio has an anticipated coverage of 40 square feet (3.7 square meters) to produce a 40 mil (1 mm) thickness on a smooth surface. A grid pattern shall be marked out on the deck surface prior to epoxy placement so this coverage rate can be monitored.

After mixing of the components, the resin shall be evenly distributed on the clean, dry deck surface. The ambient air, deck surface, and epoxy temperatures shall be between 65° F and 90° F (18° C to 32° C) at the time of placement. Workers shall not be allowed to walk on the epoxy or cover aggregate until the epoxy has fully cured.

Do not place epoxy on the deck surface in a larger area than can be broadcast with aggregate as specified in Section 491.3.C.2.

When the plans require the Contractor to place the Epoxy Chip Seal under traffic, phased construction will be required. The Contractor shall maintain a straight line between the phases of epoxy placement by masking the line between phases with duct tape, or a material approved by the Engineer, and removing this masking before the epoxy achieves initial set.

Product safety data sheets shall be supplied by the manufacturer and made available to all workers and inspectors exposed to the epoxy material.

The epoxy shall cure a minimum of 8 hours before traffic is allowed on the deck surface.

2. Cover Aggregate Application Requirements: Soon after resin application, a very light broadcast of cover aggregate shall be applied to break any bubbles that may have formed during the resin application and to test the viscosity of the epoxy resin adhesive to determine when the final broadcast of cover aggregate may be made. The viscosity of the resin at the time of final broadcast (approximately 15 to 20 minutes, but may vary depending on temperature) should be such that the cover aggregate, when lightly broadcast, settles into the resin, but such that the resin is viscous enough that the resin will not be pulled up off of the deck surface by capillary action. The final broadcast of cover aggregate needs to be completed, before the resin becomes too stiff such that it will not penetrate into the epoxy. The final broadcast shall be made to refusal such that:

a. A uniform layer of cover aggregate is achieved over the entire deck surface.
b. There are no visible shiny wet spots on the deck surface after application.
c. No excess build-up of cover aggregate exists.

Cover aggregate is required to be broadcast by hand-seeding, or other approved method, in such a manner the aggregate is falling vertically to the deck surface to prevent pushing of the resin. Broadcasting with shovels is not allowed. Total application rate of cover aggregate after final broadcast will be approximately 1 to 1.5 lb./sq. ft. (4.88 to 7.32 kg/sq. m.).

3. Clean up of Excess Cover Aggregate Requirements:

The epoxy shall be allowed to cure a minimum of 8 hours before excess aggregate is removed.

Excess aggregate will be removed by brooming, high pressure filtered air removal or vacuuming as approved by the Engineer.

491.4 METHOD OF MEASUREMENT

A. Remove Rubberized Asphalt Chip Seal: Measurement will not be made for Remove Rubberized Asphalt Chip Seal. The plan quantity will be the basis of payment.

B. Bridge Deck Grinding: Measurement will not be made for Bridge Deck Grinding. The plan quantity will be the basis of payment.

C. Abrasive Blasting of Bridge Deck: Measurement will not be made for Abrasive Blasting of Bridge Deck. The plan quantity will be the basis of payment.

D. Remove and Replace Deteriorated Concrete: Remove and Replace Deteriorated Concrete will be measured to the nearest 0.1 foot (10 mm) and the area will be computed to the nearest 0.1 square yard (0.1 square meter).

E. Epoxy Chip Seal: Measurement will not be made for Epoxy Chip Seal Placement. The plan quantity will be the basis of payment.

491.5 BASIS OF PAYMENT

A. Remove Rubberized Asphalt Chip Seal: Remove Rubberized Asphalt Chip Seal will be paid for at the contract unit price per square yard. Payment will be full compensation for labor, equipment, materials, and all incidental work required.

B. Bridge Deck Grinding: Bridge Deck Grinding, when specified in the plans, will be paid for at the contract unit price per square yard. Payment shall be full compensation for equipment, labor, and incidentals necessary to grind the deck surface to the required profile and to remove grinding residue and excess water.

C. Abrasive Blasting of Bridge Deck: Abrasive Blasting of Bridge Deck will be paid for at the contract unit price per square yard. Payment shall be full compensation for equipment, labor and incidentals necessary to shot blast and abrasive blast clean the deck surface of all foreign materials which may interfere with the bonding or curing of the Epoxy Chip Seal. Such payment shall also include all costs associated with vacuum cleaning the bridge deck to remove dust and loose materials immediately after the abrasive blasting.

D. Remove and Replace Deteriorated Concrete: Remove and Replace Deteriorated Concrete, when specified in the plans, will be paid for at the contract unit price per square yard. Payment shall be full compensation for equipment, materials, labor and incidentals necessary to remove loose, deteriorated concrete or bituminous material, cleaning removal areas, disposal of removed materials and furnishing, placing and curing new concrete place within the removal areas.

E. Epoxy Chip Seal: Epoxy Chip Seal will be paid for at the contract unit price per square yard. Payment will be full compensation for labor, equipment, materials, and all incidental work required.